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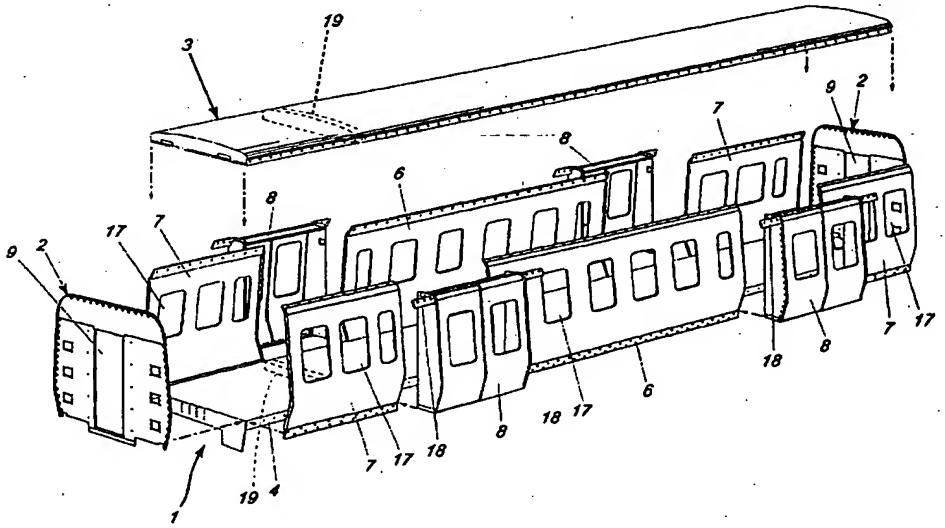
[Continued on next page]

(54) Title: A RAIL VEHICLE CARBODY OF MODULAR CONSTRUCTION



(57) Abstract: A carbody for a railbound vehicle of a modular construction comprising a floor module (1), a roof module (3), each forming single piece, self supporting structures, two end structures (2) and sides. The sides comprise vertical elements that are joint at the top to the roof module and at the bottom to the floor module and at the side to an adjoining vertical element or to an end structure. The vertical elements comprise wall modules (6, 7) and door modules (8). The door modules are self-supporting, structural parts mainly contributing to the cross-sectional strength of the vehicle, and the wall modules are thin, self-supporting structures and mainly contributes to the longitudinal strength of the vehicle. The door modules and said wall modules are the only structural parts of the sides. All joints are made with cold joining methods only.

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(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A rail vehicle carbody of modular construction

The present invention relates to a modular concept for a carbody of a rail vehicle wherein all modules are structural.

BACKGROUND TO THE INVENTION

Conventional rail vehicles often have a carbody construction comprising a load-bearing framework of longitudinal, vertical and transversal beams welded together. An outside panel of flat or corrugated sheet material is welded or riveted to the beams. Insulating material is placed between beams and covered with an inner panel.

This kind of conventional carbodies is impaired with a number of drawbacks: The assembly is inevitably sequential, which makes lead-time and assembly time long. The assembly is also vulnerable to delay since the next operation cannot be started until the previous one is finished. The ergonomic and logistic conditions of the process are difficult.

Welding introduces aesthetic and constructional weaknesses in the finished car body.

The weight of the vehicle is high since a great part of the material constitutes non-structural panels and isolation.

The walls are thick since heavy beams are needed to support the structure.

Many train manufacturers try to solve problems with conventional rail vehicles by introducing a modular carbody.

The patent US 5,797,646 describes a modular rail or road vehicle with roof and chassis that has sidewalls comprising frames. The frames are the only structural parts of the sidewalls. A frame could be covered by panel or could include windows or doors. There are also non-structural parts of the side walls that comprise panelling or windows.

A disadvantage with this construction is that very high forces have to be taken up by the structural parts in case of a frontal collision. If large parts of the sides are non-structural the entire load must be taken up by the roof and chassis elements.

The document EP 0605366 A1 shows a construction of an annular series of hollow structural panels. The longitudinal edges of each structural panel are rigidly connected to the corresponding longitudinal edges of the adjacent panels by means of continuous welding.

Prior art vehicles designed this way suffer from the following draw-backs; welding introduces structural and aesthetic weaknesses in the construction; and the construction does not permit a high degree of sub-assembly since electrical fittings, paint, trimmings, windows and other equipment has to be mounted after the welding operation.

SUMMARY OF THE INVENTION

One object with the present invention is to obtain a carbody with thin walls for large inner space. The walls should be uninterrupted by struts, beams and framework. The larger inner space makes it possible to seat more people or to increase passenger comfort.

Another object is to avoid welding so as to eliminate the structural weaknesses and the irregular surfaces introduced by welding.

Another object is to make production time and labour effective. This is obtained by having a high degree of sub-assembly.

Another object is to reduce the weight of the vehicle by minimising the material that does not contribute to the strength of the vehicle. A lower weight gives several positive effects such as reduced cost for fuel, lower impact on wheels and axles and less wear of rails.

The present invention relates to a modular carbody for rail vehicles and a method to manufacture the carbody. The roof and floor are separate, one-piece structural elements: roof and floor modules, which together with vertical structural elements form a carbody structure. The vertical elements can include a door and then constitutes a door module or a window and then constitute a wall-module.

Additional elements close the structure in the ends forming gables, driver's cabs or other end structures. These elements do not contribute greatly to the longitudinal strength of the vehicle, but contribute mainly to the cross-sectional strength of the carbody. The end structures are also important for the integrity of the carbody.

The wall modules contribute mainly to the longitudinal strength of the vehicle. The door modules and end structures contribute mainly to the cross-sectional strength as well as possible internal reinforcements in the form of partition walls. The floor and roof modules are of course both longitudinally and transversally strong. Stiffening members could be integrated in the roof and floor modules where extra strength is needed as for example in connection to door modules and bogies. The stiffening members could be beams of steel of the same thickness as the core material. The flexural resistance of the wall modules, the roof module and the floor module together with the door modules co-operate with roof and floor to form a strong cage, which effectively protects passengers in case of derailment.

The wall modules should be uniformly thin across the length of the module, preferably 20-80 mm thick. The thinnest of today's conventionally constructed carbodies have a wall thickness of 72 mm. Depending on demands on thermal insulation and strength, a wall of structural elements can be made with a thickness of 20 mm, but a wall thickness of more than 30 mm is preferred to facilitate the fitting of windows in the walls.

A further advantage with the modular concept of the invention is that wall modules and door modules are individually replaceable. If there is local damage to one module it can be removed and replaced by a similar module. It would also be possible to re-design the vehicle after some years of service to have more doors or a different layout.

Windows can be glued into the wall modules to contribute to the shearing strength or they can be fitted in, in such a way that only very small forces are transferred to the glass.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an exploded view of a modular carbody according to the invention.

Figure 2 shows a door-module.

Figure 3 show a carbody with an internal reinforcement for cross-sectional loads.

Figure 4 shows a wall module constructed in sandwich material with terminations and internal stiffening members

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 show a modular carbody for rail vehicles according to a preferred embodiment of the invention. The carbody comprise a roof module **3** and a floor module **1**. The roof module and floor modules are separate, one-piece structural elements that together with modules form a carbody structure. The side modules can include a door and then constitutes a door module **8** or a window **17** and then constitute a wall-module **6,7**. Either the wall modules or the door modules can comprise an upper flange **18** protruding in the joint area behind the adjoining module for distributing loads.

The modules can be arranged with internal stiffening members **19** as shown in figure 1. The stiffening members could be placed in the roof module and floor module to take up loads between door modules or above bogies. The stiffening members could also be located below windows to support and facilitate the mounting of seats.

Additional elements close the structure in the ends forming gables, articulations, driver's cabs or other end structures **2**.

Figure 2 shows a door module that comprises a doorframe **21** and door blades **22**. The doorframe is designed to mainly bear cross sectional loads. The door modules are completely pre-assembled and tested with door-blade, door-operating machinery **23**, and seal between door blades and doorframe. The module can be provided with paint or trimmings.

The wall modules are pre-fabricated with most required details before the assembly of the carbody. The wall modules can be fully equipped with windows, electrical fittings, heating devices, air ducts and decorative panels or paint when required. Support structures for seats, shelves and compartment walls are also possible to pre-assemble.

The floor module is completely pre-assembled and provided with a floating floor arrangement; an inner floor that rest on damping means, which inner floor is fitted with carpeting.

The floor module, in another embodiment of the invention, also include the underframe and underframe equipment such as cabling, traction equipment, converters, transformers, pneumatic system etc (not shown).

The roof module is also completely pre-assembled with electrical fittings, ventilation means as for example air-conditioning apparatus, air ducts and air distribution means, internal and/or external panels, trims or coats of paint and light fixtures. Fixtures for stanchions and handrails could also be pre-assembled. Even pantographs could be included in the roof module.

The segment of a carbody shown in figure 3 has an internal reinforcement **31**. The reinforcement is arranged to mainly contribute to the cross-sectional strength of a vehicle. The reinforcements can be used for very long vehicles with long intervals between doors and gables. The reinforcement can coincide with a partition wall, when a partition wall is wanted in the vehicle.

In one embodiment of the invention a sandwich material is used (see figure 4) with an outer metal skin **41**, an insulating core **42** and an inner skin **43**. The sandwich material, which has very good structural, acoustic and isolating properties, is preferably used for parts of wall modules, roof modules and floor modules, but could also be used in reinforcements or end structures. Terminations **44** could also be included in this kind of sandwich material to protect the core and to facilitate joining of modules. The layers of the sandwich are preferably joined by viscoelastic glue that have vibration damping properties as well as good bonding properties. The glue can also be made electrically conductive for earthing purposes.

In yet another embodiment a sandwich material is used with metal skins and a metal honeycomb core.

In yet another embodiment an extruded aluminium profile is used.

Joints between the different parts of the vehicle are made with cold methods, preferably with rivets or bolts or most preferably with so called Huck-bolts ™, that

are a kind of grooved fastening means that are deformed to form a joint. The edges of the modules are prepared to bear against the edge of the adjoining module and to receive the joining means.

The joint could also include a sealing means arranged to take up some vibrations in the carbody thus increasing the structural damping. Such a sealing means could comprise a strand of viscoelastic material placed in the joint at some distance from the joining means.

CLAIMS

1.—A carbody for a railbound vehicle of a modular construction comprising a floor module (1), a roof module (3), each forming single piece, self supporting structures, two end structures (2) and sides,
which sides comprise vertical elements, joint at the top to the roof module and at the bottom to the floor module and at the side to an adjoining vertical element or to an end structure
characterised in
that the vertical elements comprise wall modules (6, 7) and door modules (8),
which door modules are self supporting, structural parts mainly contributing to the cross-sectional strength of the vehicle,
and which wall modules are thin, self supporting structures and mainly contributes to the longitudinal strength of the vehicle,
and that said door modules and said wall modules are the only structural parts of the sides,
and that all joints are made with cold joining methods only.

2. A carbody according to claim 1 wherein the door modules comprise a structural door-frame with a door manoeuvring device and a door blade mounted to the door frame and a sealing means between said door-blade and door frame.

3. A carbody according to claim 1 or 2 wherein the wall modules comprise at least one glazed portion (17), and is provided with required fittings and trims.

4. A carbody according to any preceding claim wherein the roof module (3) is pre-fabricated and provided with all fittings and trims.

5. A carbody according to any preceding claim wherein the floor module (1) comprise an inner floor that is fitted with carpeting.

6. A carbody according to any preceding claim wherein the floor module comprise an underframe and underframe equipment.

7. A carbody according to any preceding claim wherein all joints between modules are secured by rivets or bolts or preferably huck-bolts.

8. A carbody according to claim 7 wherein the joints comprise a viscoelastic sealant placed spaced apart from the rivet or bolt in the joint, which viscoelastic sealant is arranged to contribute to damping of structural sound and vibrations in the carbody.

9. A carbody according to any preceding claim wherein at least one reinforcement (31) is placed on the inside of the carbody, which reinforcement mainly contributes to the cross-sectional strength of the vehicle and which reinforcement coincides with a partition wall.

10. A carbody according to any preceding claim wherein the wall modules, roof module and/or floor module comprise steel skinned sandwich material with an insulating core.

11. A carbody according to any preceding claim wherein the wall modules, roof module and/or floor module comprise steel skinned (41,43) sandwich material with an insulating core (42) and terminations (44,45), all of which are joined by adhesive, which terminations are arranged to protect the core material and to form joints to adjoining module, window or end structure.

12. A carbody according to any of the claims 1-10 wherein the wall modules, roof module and/or floor module comprise steel skinned (41,43) sandwich material with an insulating core (42) and stiffening members (19).

13. A carbody according to any of the claims 1-10 wherein the wall modules, roof module and/or floor module comprise a sandwich with steel skin and steel honeycomb core.

14. A carbody according to any of the claims 1-10 wherein the wall modules, roof module, floor module and/or reinforcement comprise extruded aluminium sections.

15. A carbody according to any preceding claim wherein at least one of the wall modules or the door modules comprise an upper flange (18) protruding in the joint area behind the adjoining module, which flange is arranged to continuously distribute loads.

16. A method for manufacturing a carbody for a railbound vehicle of a modular construction comprising the steps of:

a) individually pre-fabricating a roof module, a floor module, a plurality of wall modules and a plurality of door modules each of which are self supporting, structural, single piece structures,

b) individually prefabricating two end structures, and

c) joining the door modules and the wall modules at the bottom to the floor module, at the top to the roof module and at the side to adjoining wall modules, door modules or end structures using cold methods only.

17. A method according to claim 17 wherein the floor module and the roof module are fully equipped with their respective fittings

18. A method according to claim 17 or 18 wherein door modules comprise a door-frame, a door-blade, a manoeuvring device and a seal between door-frame and door-blade

19. A method according to any of the claims 17-19 wherein the wall modules comprise at least one glazed portion (17).

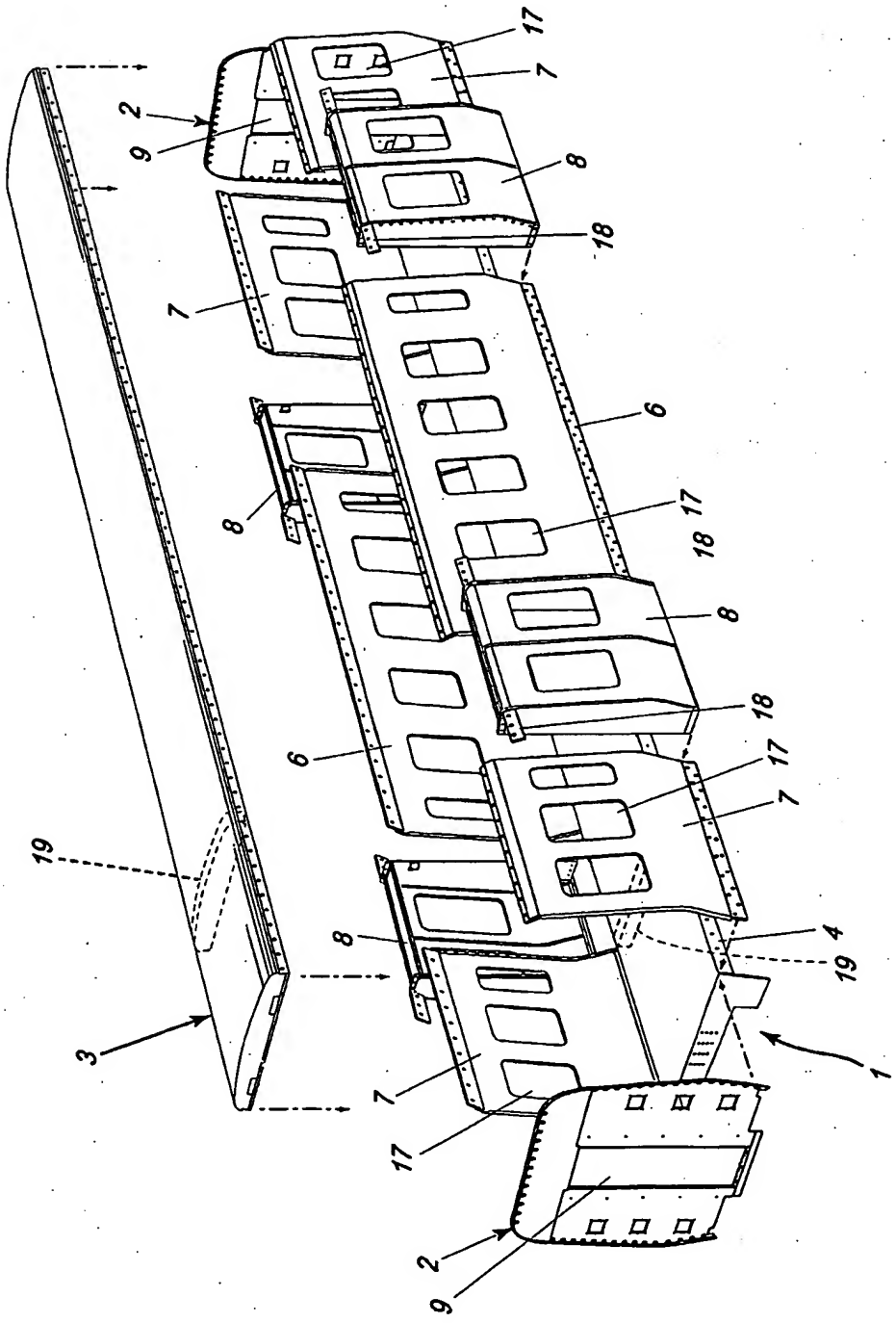

Fig-1

SUBSTITUTE SHEET (RULE 26)

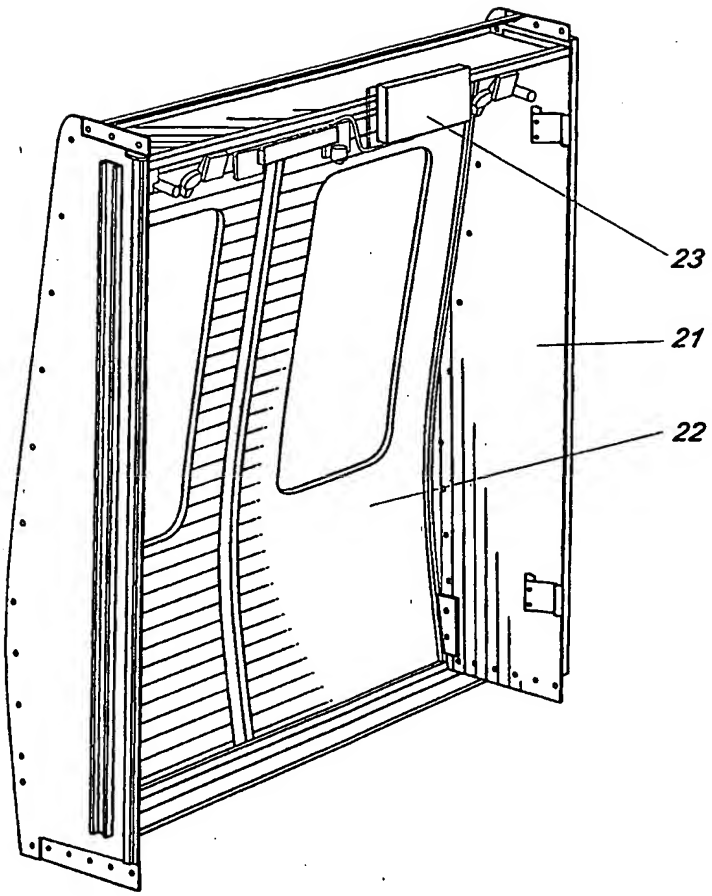

Fig-2

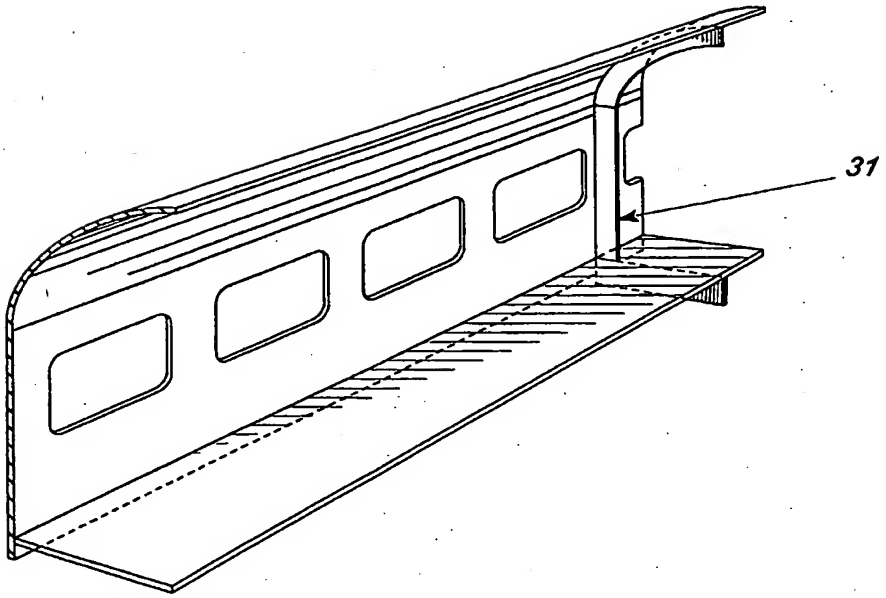

Fig-3

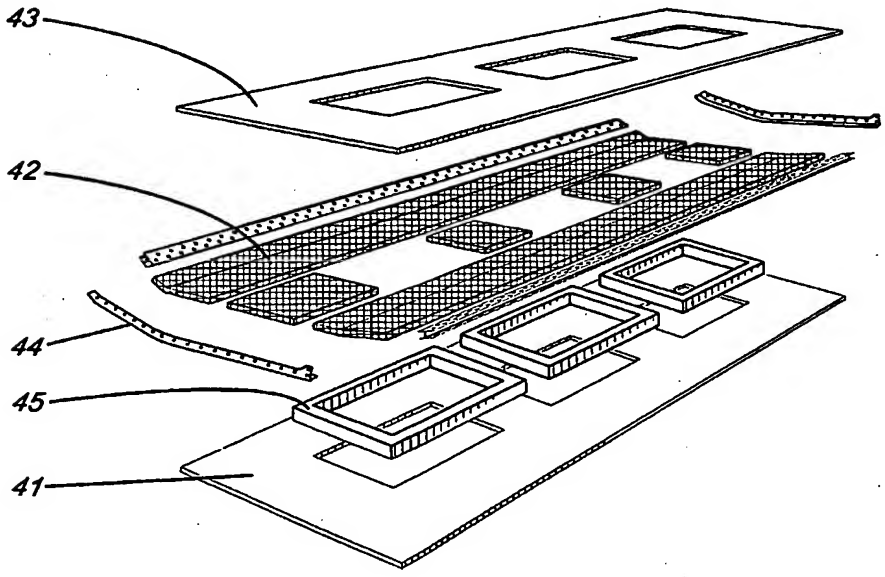

Fig-4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00109

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B61D 17/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B61D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5797646 A (SYLVIE JEUNEHOMME ET AL), 25 August 1998 (25.08.98), column 4, line 38 - column 5, line 55, figures 1-3, abstract	1-19
A	EP 0818373 A2 (HOOGOVENS ALUMINIUM PROFILTECHNIK BONN GMBH), 14 January 1998 (14.01.98)	1-19
A	EP 0605366 A1 (FIAT FERROVIARIA S.P.A.), 6 July 1994 (06.07.94)	1-19
A	WO 9823475 A1 (DUEWAG AKTIENGESELLSCHAFT), 4 June 1998 (04.06.98)	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 April 2002	29 -04- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Jönsson/AGE Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

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Information on patent family members

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(74) Agent: **CARLSSON, Sara**; Bombardier Transportation Sweden AB, S-721 73 Västerås (SE).

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(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

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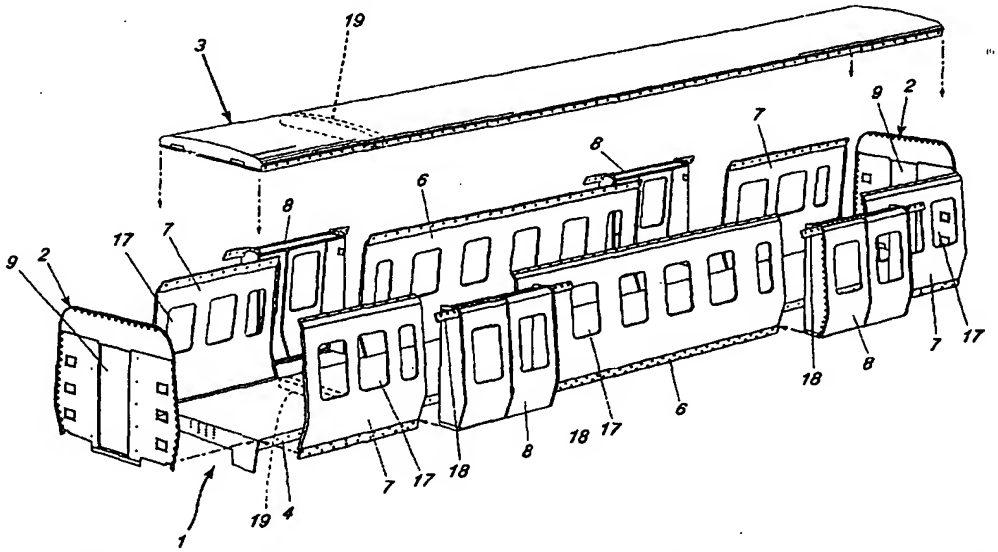
(54) Title: A RAIL VEHICLE CARBODY OF MODULAR CONSTRUCTION



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European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

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